

CLAIMS

We claim:

1. A method of causing light emission from carbon nanotubes, comprising exposing carbon nanotubes to microwave irradiation.
2. A method of causing mechanical motion of carbon nanotubes, comprising exposing carbon nanotubes to microwave irradiation.
3. A method of causing carbon nanotube reconstruction, comprising exposing carbon nanotubes to microwave irradiation.
4. A method of outgassing absorbed or adsorbed species from carbon nanotubes, comprising exposing carbon nanotubes to microwave irradiation.
5. The method of Claim 4, wherein the carbon nanotubes are subjected to microwave irradiation while in an inert gas chamber.
6. The method of Claim 4 wherein the carbon nanotubes comprise single-walled carbon nanotubes.
7. The method of Claim 4 wherein the carbon nanotubes comprise multi-walled carbon nanotubes.
8. The method of Claim 4, wherein the carbon nanotubes are subjected to microwave irradiation while in a vacuum chamber.
9. The method of Claim 8, wherein the vacuum is between approximately 10^{-4} torr and 10^{-8} torr; and
 - the microwave frequency is between 0.1 GHz and 100 GHz.
10. The method of Claim 8, wherein the vacuum is between approximately 10^{-4} torr and 10^{-8} torr;
 - the microwave frequency is about 2.45 GHz; and
 - the microwave power is between 0.1 Watt and 1,500 Watts.
11. The method of Claim 4, wherein the microwave field incident upon the carbon nanotubes is about 1.01×10^{-5} eV.
12. An apparatus for desorbing an absorbed or adsorbed species, element or gas from carbon nanotubes, comprising:
 - a carbon nanotube source containing an absorbed or adsorbed species, element or gas;
 - a microwave source located proximate to the carbon nanotube source; and

a device for directing microwaves from the microwave source toward and through the carbon nanotube source.

13. The apparatus of Claim 12, wherein the gas desorbed is hydrogen.
14. The apparatus of Claim 12, for use as a hydrogen fuel storage and delivery system.
15. The apparatus of Claim 12, for use in an automobile.
16. The apparatus of Claim 12, for use in a space vehicle.
17. The apparatus of Claim 12 wherein the carbon nanotube source is comprised of single-walled carbon nanotubes.

18. The apparatus of Claim 12 wherein the carbon nanotube source is comprised of multi-walled carbon nanotubes.

19. The apparatus of Claim 12, wherein the microwave source generates a frequency between 0.1 GHz and 100 GHz and the microwave source delivers power of between 0.1 Watt and 1,500 Watts.

20. The apparatus of Claim 12, wherein the microwave source generates a frequency of about 2.45 GHz; and the microwave source delivers power of between 0.1 Watt and 1,500 Watts.

21. The apparatus of Claim 12, wherein the carbon nanotube source is bathed in a microwave field of about 1.01×10^{-5} eV by the microwave source.

22. The apparatus of Claim 12, wherein the microwave source comprises a portable microwave generator.

23. The apparatus of Claim 12, wherein the microwave source comprises at least one dual cavity klystron with planar triodes.

24. The apparatus of Claim 12, wherein the microwave source comprises at least one reflex klystron.

25. The apparatus of Claim 12, wherein the microwave source comprises at least one backward wave oscillator.

26. The apparatus of Claim 12, wherein the microwave source comprises at least one magnetron.

27. The apparatus of Claim 12, further comprising:

- a device for producing a vacuum;
- the microwave source being located proximate to the device for producing a vacuum; and

a substantially microwave transparent mechanism for holding said carbon nanotube source securely within the device for producing the vacuum; and

the device for directing microwaves from the microwave source toward and through the carbon nanotube source being directed to the substantially microwave transparent mechanism.

28. The apparatus of Claim 27, wherein the vacuum produces between approximately 10^{-4} torr and 10^{-8} torr; and

the microwave source generates a frequency between 0.1 GHz and 100 GHz; and
the microwave source delivers power of between 0.1 Watt and 1,500 Watts.

29. The apparatus of Claim 27, wherein the vacuum produces between approximately 10^{-4} torr and 10^{-8} torr;

the microwave source generates a frequency of about 2.45 GHz; and
the microwave source delivers power of between 0.1 Watt and 1,500 Watts.

30. The apparatus of Claim 27, wherein the carbon nanotube source is bathed in a microwave field of about 1.01×10^{-5} eV by the microwave source.

31. The apparatus of Claim 12, wherein the element or gas desorbed is oxygen.

32. The apparatus of Claim 12, wherein the element or gas desorbed is nitrogen.

33. The apparatus of Claim 12, wherein the element or gas desorbed is argon.

34. A method of implanting hydrogen in carbon nanotubes for use as a fuel storage medium, comprising:

placing carbon nanotubes under vacuum;

accelerating the hydrogen toward a carbon nanotube source using an ion beam line process;
and

impacting the hydrogen on the carbon nanotube source using an acceleration potential of 5 keV at a rate of about 1 particle every 10^{-9} seconds.

35. An apparatus for implanting hydrogen in carbon nanotubes for use as a fuel storage medium, comprising:

a source of carbon nanotubes under vacuum; and

an acceleration means located proximate the source of carbon nanotubes for accelerating hydrogen atoms toward the carbon nanotube source.

36. The apparatus of Claim 35, wherein the acceleration means comprises an ion beam accelerator.

37. The apparatus of Claim 35, wherein the ion beam accelerator is capable of implanting about 1 hydrogen particle in the carbon nanotube source every 10^{-9} seconds.

38. An apparatus for welding nanotubes or nanotube-based ropes in their pure states or after dispersion in blends or composites, comprising:

a carbon nanotube source;

an device for producing a vacuum;

a microwave source located proximate to the device for producing a vacuum;

a substantially microwave transparent mechanism for holding said carbon nanotube source securely within the device for producing a vacuum; and

a device for directing microwaves from the microwave source toward and through the carbon nanotube source.